DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES

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denr.sd.gov

RECOMMENDATION OF CHIEF ENGINEER FOR WATER PERMIT APPLICATION NO. 8068-3, Thunder Ridge RE, LLC

Pursuant to SDCL 46-2A-2, the following is the recommendation of the Chief Engineer, Water Rights Program, Department of Environment and Natural Resources concerning Water Permit Application No. 8068-3, Thunder Ridge RE, LLC, c/o Dr. Luke Minion, PO Box 188, Pipestone MN 56164.

The Chief Engineer is recommending DEFERRAL of Application No. 8068-3 for one year in order to have a sufficient period of record in observation wells to determine if water levels have equilibrated in the Sioux Quartzite Wash in this area.

See report on application for additional information.

Jeanne Goodman, Chief Engineer
February 6, 2015

NOTE: The application will be brought back before the Water Management Board at their March 2016 meeting. Thunder Ridge RE LLC may divert water for livestock watering without a water permit provided "reasonable domestic use" is not exceeded. Reasonable domestic use is the use of 25,920 gallons of water per day or less as necessary for domestic purposes, with a maximum pumping capacity of 25 gallons per minute.

REPORT TO THE CHIEF ENGINEER
ON
WATER PERMIT APPLICATION NO. 8068-3
THUNDER RIDGE RE, LLC.
JANUARY 3, 2015

Water Permit Application No. 8068-3 proposes to appropriate water at a maximum diversion rate of 0.11 cubic feet of water per second (cfs) from two wells to be completed into the Sioux Quartzite Wash aquifer. The wells are expected to be approximately 272 feet deep and will be located in the N½ NE¼ Sec. 19, T100N-R55W. Water is to be used for commercial use in a swine confinement facility.

AQUIFER: SIOUX QUARTZITE WASH (SXWS)

AREA GEOLOGY AND HYDROLOGY:
The "Source of water supply" was identified on this permit application as the "West Management Unit of the Upper Vermillion Missouri". The name Upper Vermillion Missouri aquifer is a misnomer for a buried glacial outwash deposit that D. Holly first identified and termed the basal-outwash aquifer (as cited in Schulz, 1991, p. 3). Lindgren and Hansen (1990) mapped Holly's basal-outwash aquifer as an extension of the Upper Vermillion-Missouri aquifer. The SD DENR-Water Rights Program conformed to the Lindgren and Hansen nomenclature and has considered the basal glacial outwash deposit in this area a part of the Upper Vermillion-Missouri aquifer. Recent evaluation of data suggests that the basal glacial outwash deposit in this area should be considered hydrologically distinct from the Upper Vermillion-Missouri: West aquifer (Buhler, 2014). For the purposes of this report, the basal glacial outwash deposit will be identified as the "Basal-outwash aquifer".

The well sites proposed by this application overlie or nearly overlie the Basal-outwash aquifer as delineated by Schulz, (1991). This aquifer generally lies within a narrow, north-south trending, steeply sloped, bedrock valley in this area (see Figure 1).

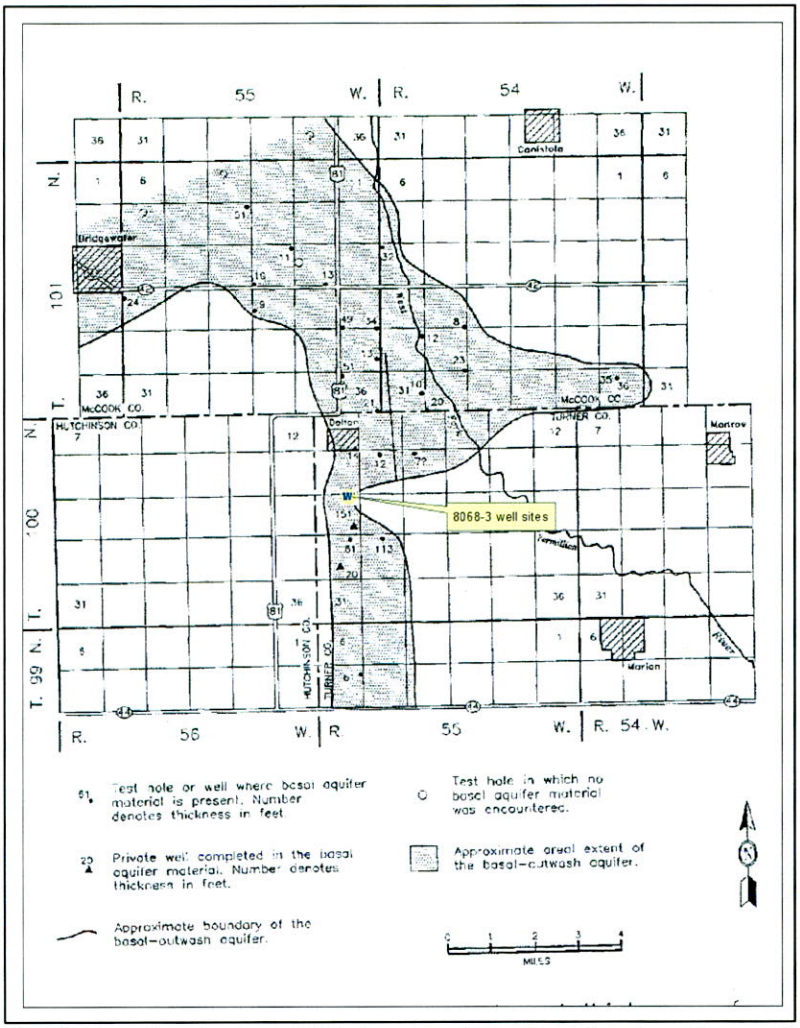


Figure 1. Approximate areal extent and thickness of the basal-outwash aquifer (modified from Schulz, 1991)

However, the completion report of a well that was constructed for this project identifies the source aquifer material, which is located at a depth of 250-272 feet below grade, as "Hard Sand". Through subsequent discussions, the well driller indicated that the aquifer material was a "hard, white, cemented sand", was "not gray gravel", and was not "granite sand" (E.Schoenwald, personal communication, January 15, 2015). This aquifer material description is not consistent with a glacial outwash material and is more appropriate to bedrock.

The bedrock in this area consists of the Precambrian Sioux Quartzite, pre-Cretaceous (?) quartzite wash and Cretaceous sediments (Schulz, 1991). The three major bedrock aquifers identified in Hutchinson and Turner Counties are the Niobrara aquifer, the Codell aquifer and the Dakota aquifer (Lindgren and Hansen, 1990). Lindgren and Hansen (1990) also considered the Sioux Quartzite a minor aquifer in this area. Although they indicated the Sioux Quartzite Wash is permeable, attains a maximum thickness of 125 feet, and "Wells may yield as much as 250 gallons per minute", Lindgren and Hansen (1990) did not recognize it as an aquifer.

Geologists have described the material they encountered overlying the basement Sioux Quartzite in this area in various ways. The geologist (Tomhave) for a test hole drilled approximately eight miles north-northwest of the well sites proposed by this application reported "Sand, Pink: Quartz-rich, cemented (Cretaceous undifferentiated)" overlying the basement rock. Eighty-seven feet of the Cretaceous aged Split Rock Creek Formation was identified, by the geologist (Schulz) in a test hole drilled approximately 4.4 miles north-northwest of the well sites proposed by Application No. 8068-3. Schulz also postulated that a test hole 2.7 miles northeast of this site encountered the Split Rock Creek Formation. The geologist (Holly) reported a sequence including "mudstone to sandstone; very fine sand, clayey...", overlying a "Sandstone; fine to coarse sand, pinkish tint, moderate hardness...may contain several claystone layers, may be a thin coal seam at 354 feet... (Quartzite Wash?)" in Water Rights' Observation Well MC-83H, which is located approximately 5 miles northeast of the sites proposed by Application No. 8068-3 (SD Geological Survey, 2015). It is not clear whether there is an actual diversity in the geology or simply in the geologists' descriptions in this area.

A general depiction of the bedrock in this area is shown in Figure 2 (Tomhave and Schulz, 2004). Lacking an extreme density of test holes, detail is not available to accurately map the bedrock sequence identified as Cretaceous Undifferentiated in this area. In a general sense, the terms Sioux Quartzite Wash, Split Rock Creek and Cretaceous Undifferentiated may be synonymous (D.Iles, personal communication, January 20, 2015).

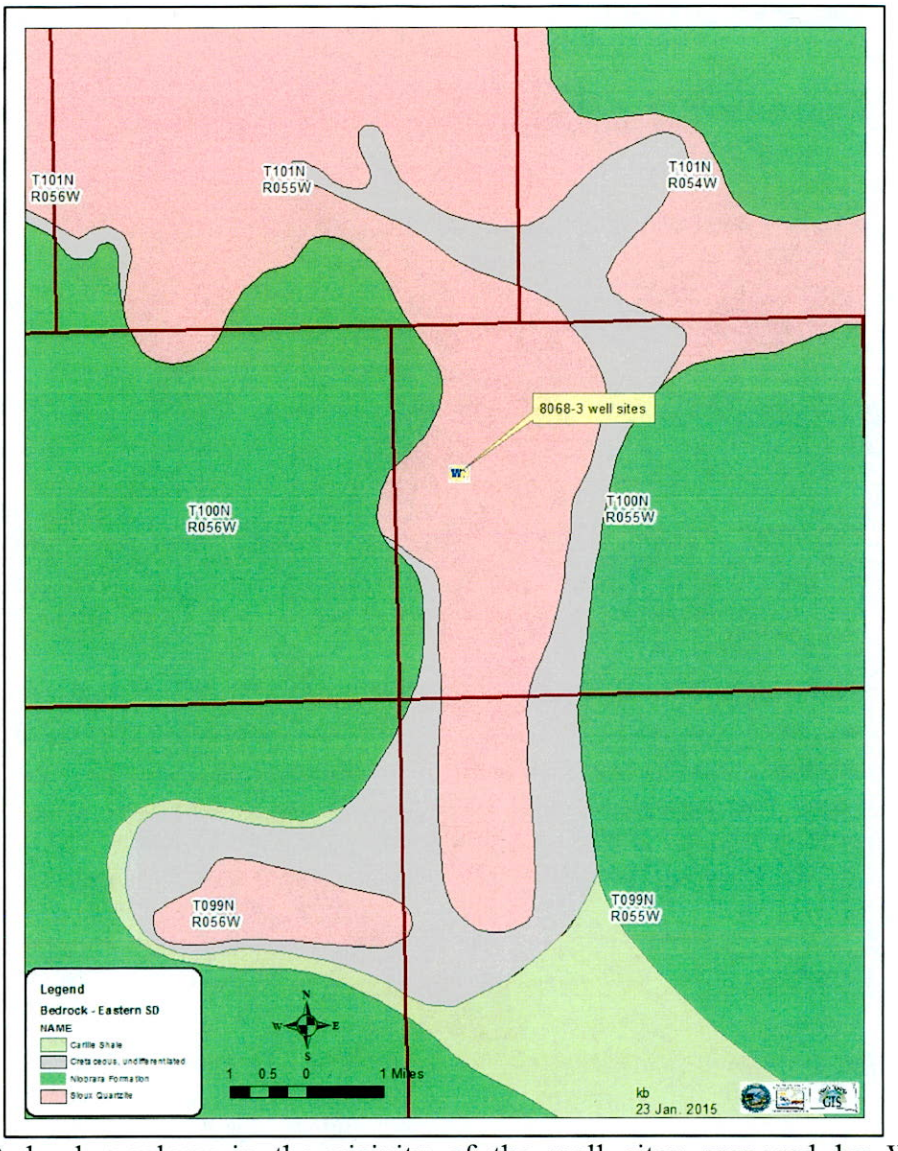


Figure 2. Bedrock geology in the vicinity of the well sites proposed by Water Permit Application No. 8068-3 (modified from Tomhave and Schulz, 2004)

The likely water source for the completed well that this application proposes to use is Undifferentiated Cretaceous/Sioux Quartzite Wash and will be referred to as the Sioux Quartzite Wash aquifer in this report. The areal extent of the aquifer has not been delineated, and it is not likely that the Sioux Quartzite Wash aquifer is a single contiguous unit. The Sioux Quartzite Wash aquifer is under confined conditions in this area and the static water level reported on the completion report submitted with this application was 90 feet below grade on October 30, 2014.

SOUTH DAKOTA CODIFIED LAW (SDCL) 46-2A-9

Pursuant to SDCL 46-2A-9, a permit to appropriate water may be issued only if there is reasonable probability that there is unappropriated water available for the applicant's proposed use, that the proposed diversion can be developed without unlawful impairment of existing rights and that the

proposed use is a beneficial use and in the public interest. This report will address the availability of unappropriated water and existing rights from the aquifer.

WATER AVAILABILITY:
This application proposes to appropriate water from the Sioux Quartzite Wash aquifer at a rate of 0.11cfs. If this application is approved, average annual water use will likely be less than 80 acre-feet annually (ac-ft/yr). The probability that unappropriated water is available from the Sioux Quartzite Wash aquifer for this proposed appropriation can be evaluated by considering SDCL 46-6-3.1 which requires "No application to appropriate groundwater may be approved if, according to the best information reasonably available, it is probable that the quantity of water withdrawn annually from a groundwater source will exceed the quantity of the average estimated annual recharge of water to the groundwater source." If the source of the water is older or lower than the Greenhorn Formation and a water distribution system has applied for a permit, the Board need not consider the recharge/withdrawal issue. Here, the aquifer may be older than or stratigraphically lower than the Greenhorn Formation, but the use would not be for a water distribution system, therefore the withdrawal/recharge issue must be considered.

In applying SDCL 46-6-3.1, the Sixth Judicial Circuit Court ruled in 2005 that if the Water Management Board uses average annual recharge, then it should also use average annual withdrawals to determine if unappropriated water is available from the aquifer (*Hines v. South Dakota Dept. of Environ. and Nat'l. Resources, Hughes County 04-37)* (Memorandum Decision, April 29, 2005).

A 2012 First Judicial Circuit Court's rulings basically stated that data must be presented to show it is probable the average annual recharge exceeds the average annual discharge by at least the amount requested by the water permit application being considered (*Hanson County Dairy v. Robert Bender and Stace Nelson*) (Memorandum Decision, April 11, 2012).

Later in 2012, the First Judicial Circuit Court stated that the determination whether or not it is probable that the quantity of water withdrawn will exceed the quantity of the average estimated annual recharge is to be based on to the best information reasonably available, and that nothing in South Dakota law requires a recharge study (*Longview Farms, LLP v. South Dakota Dept. of Environ. and Nat'l. Resources),* (Memorandum Decision, May 17, 2012).

Hydrologic Budget:
As stated above, it is not likely that the Sioux Quartzite Wash forms a single contiguous aquifer, and the areal extent of the Sioux Quartzite Wash aquifer has not been delineated in this area. Therefore, existing wells tapping the aquifer proposed by this application and their associated withdrawals cannot be quantified. In addition, the source of recharge to the Sioux Quartzite Wash aquifer has not been identified, and the recharge rate has not been quantified. Consequently, there is insufficient data to produce a hydrologic budget for the aquifer in this area.

Observation well data:
Administrative Rule of South Dakota Section 74:02:05:07 requires that the Water Management Board shall rely upon the record of observation well measurements to determine that the quantity

of water withdrawn annually from the aquifer does not exceed the estimated average annual recharge of the aquifer.

The DENR-Water Rights Program monitors two observation wells completed into the "Sioux Quartzite Wash" aquifer in this area. Observation well TU-83F is located approximately three miles east, and observation well MC-83H is located approximately four and three quarter miles northeast of the well sites proposed by this application. Hydrographs for these observation wells are shown in Figures 3 & 4.

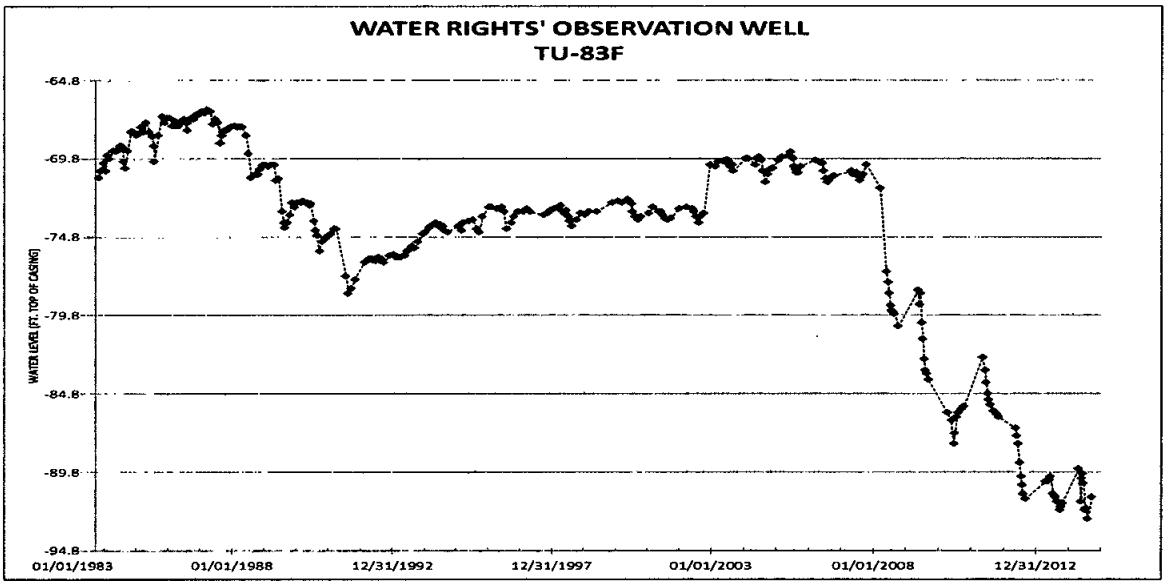


Figure 3. Hydrograph of an observation well completed into the Sioux Quartzite Wash aquifer located approximately three miles east of the well sites proposed by Application No. 8068-3 (Water Rights, 2015a).

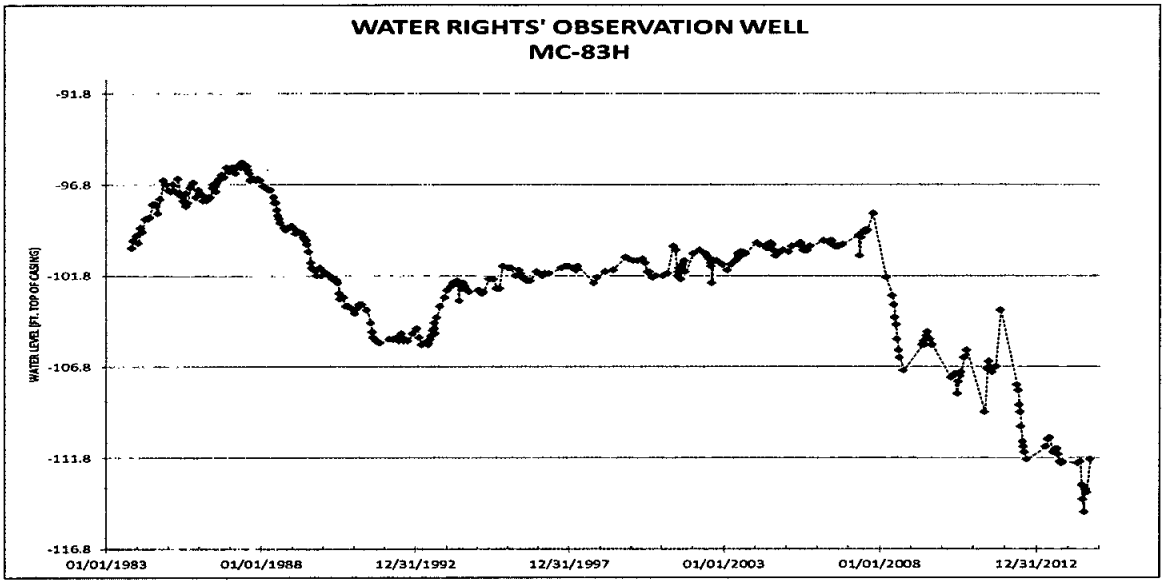


Figure 4. Hydrograph of an observation well completed into the Sioux Quartzite Wash aquifer located approximately four and three quarter miles northeast of the well sites proposed by Application No. 8068-3(Water Rights, 2015a).

Figures 3 and 4 document a decline of the potentiometric surface of the Sioux Quartzite Wash aquifer, measured at the observation wells, since October 2007. This decline has not been at a consistent rate as shown in Table 1.

Table 1. Rate of decline of the potentiometric surface at DENR-Water Rights Observation Wells TU-83F and MC-83F.

	Rate of decline per time period		
	Oct.2007-Oct. 2008	Oct.2008-Oct.2012	Oct.2012-Oct.2014
TU-83F	10.3 ft/yr	2.675 ft/yr	0.1ft/yr
MC-83F	8.6 ft/yr	1.225 ft/yr	0 ft/yr

As part of the evaluation of the hydrographs for the observation wells completed into the Sioux Quartzite Wash aquifer, they were compared to hydrographs from observation wells representative of other aquifers located within approximately 40 miles of the wells. Aquifers compared to the Sioux Quartzite Wash aquifer include the Basal-outwash (Basal), Niobrara (NBRR), Parker Centerville (PAC), Dolton (DOL), Upper Vermillion Missouri (UVM), Lower James Missouri (LJM), Vermillion East Fork (VEF), Vermillion West Fork (VWF), and Wall Lake (WAL) aquifers. Figure 5 shows hydrographs for these aquifers with water levels displayed in feet above mean sea level elevation.

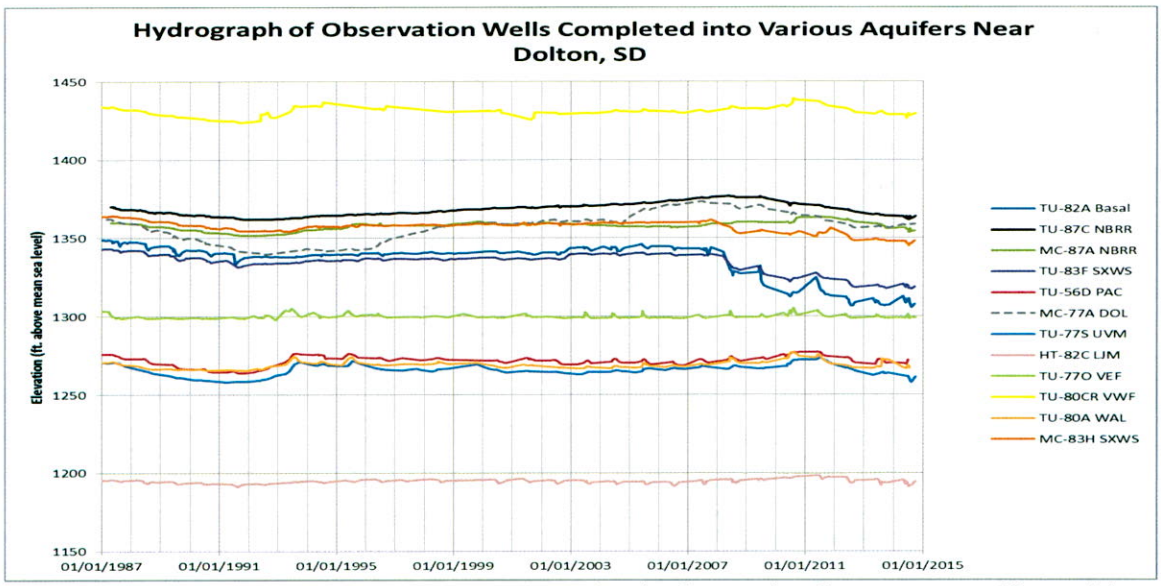


Figure 5. Composite graph showing representative hydrographs from area aquifers with water levels shown in feet above mean sea level (Water Rights, 2015a).

The mean sea level elevation of the data was eliminated by adding individual constants to each data set, allowing direct comparison of water level fluctuations as shown in Figure 6.

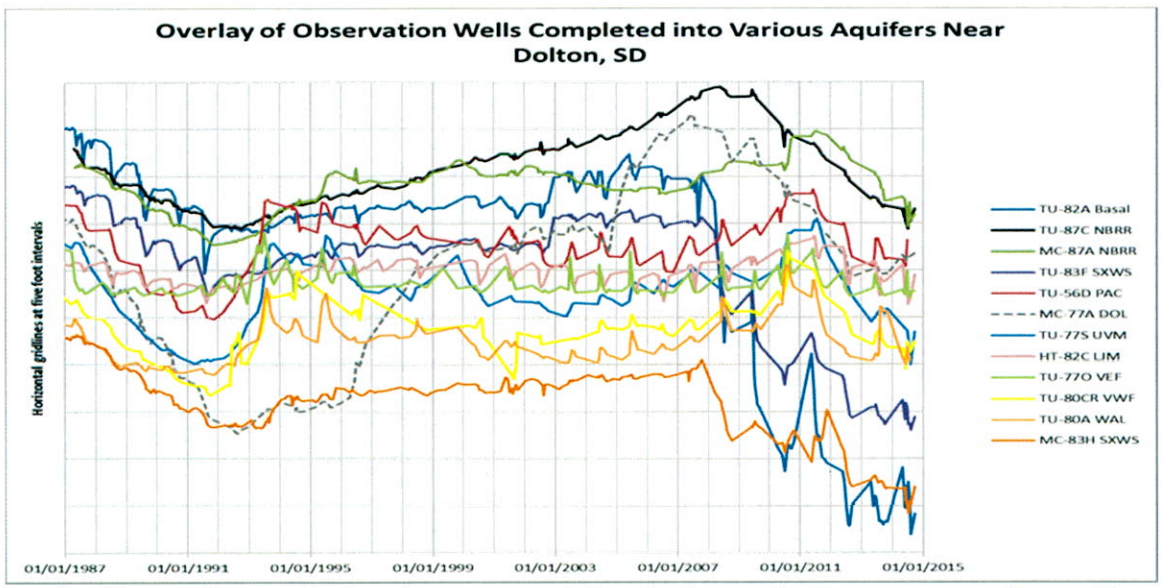


Figure 6. Composite graph showing representative hydrographs from area aquifers with mean sea level elevation eliminated to allow comparisons of water level fluctuations (Water Rights, 2015a).

Three distinct patterns are apparent in Figure 6: the hydrographs representing the Dolton aquifer and for an isolated portion of the Niobrara aquifer have similar trends which are very dissimilar to the others (Figures 6 & 7); the hydrographs for the other aquifers are similar until 2007; between 2007 and 2012, the hydrographs for the Basal-outwash and the Sioux Quartzite Wash aquifers document a decline that does not occur in the others (Figures 8 & 9).

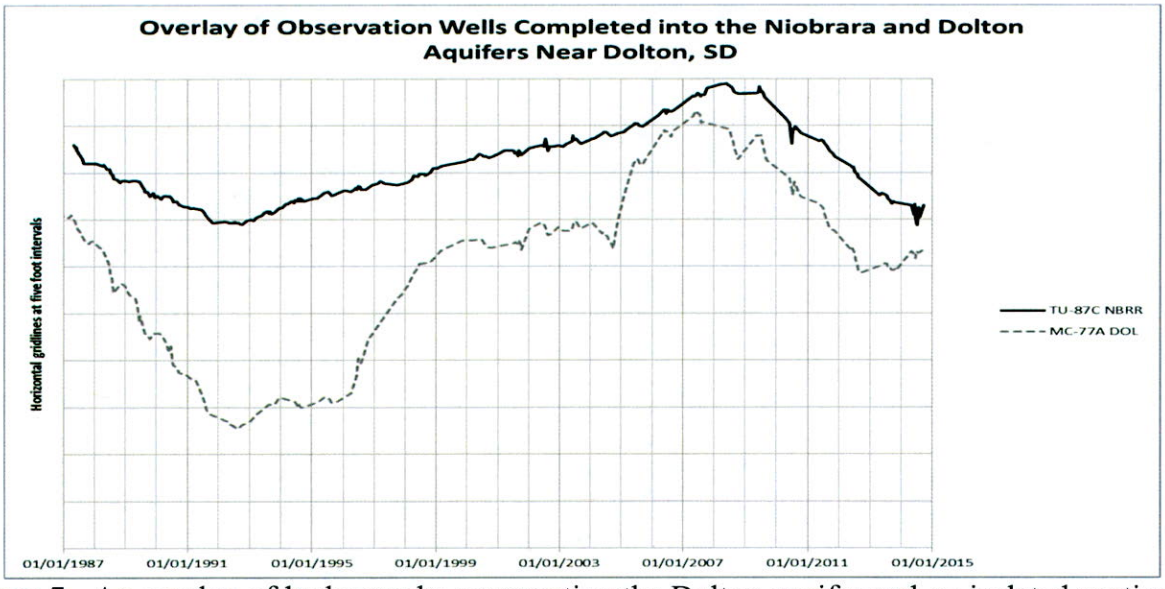


Figure 7. An overlay of hydrographs representing the Dolton aquifer and an isolated portion of the Niobrara aquifer for comparative purposes (Water Rights, 2015a).

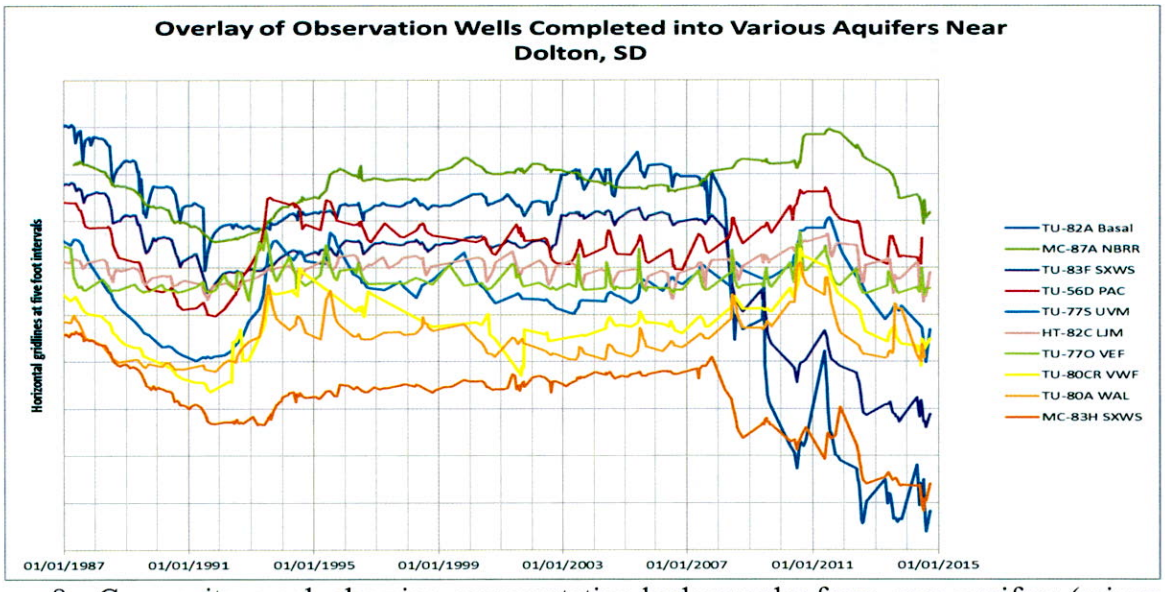


Figure 8. Composite graph showing representative hydrographs from area aquifers (minus the Dolton and an isolated portion of the Niobrara aquifer) with mean sea level elevation eliminated to allow comparisons of water level fluctuations (Water Rights, 2015a).

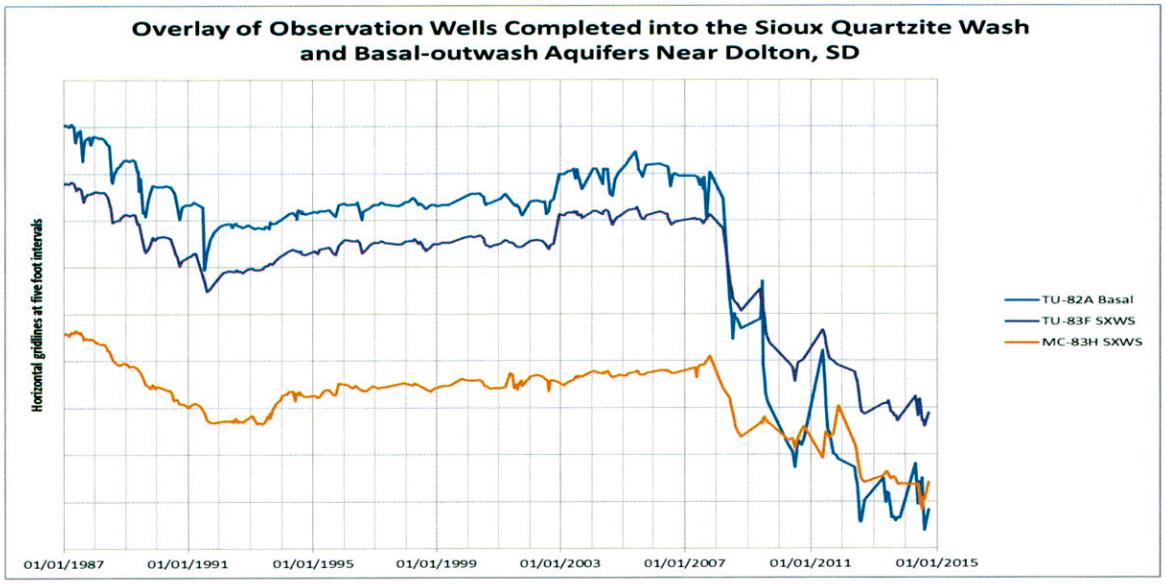


Figure 9. An overlay of hydrographs representing the Basal-outwash aquifer and the Sioux Quartzite Wash aquifers for comparative purposes.

The Basal-outwash and the Sioux Quartzite Wash aquifers appear to be responding to similar hydrologic conditions that are not affecting other aquifers in the area, and/or a hydrologic connection exists between the aquifers. The Sioux Quartzite Wash aquifer is essentially undeveloped in this area and should be under more or less under steady state conditions. However, recent development has occurred in the Basal-outwash aquifer. Well withdrawals from the Basal-outwash aquifer are primarily for appropriative uses. Water permits/rights appropriating water from the Basal-outwash aquifer are limited to rights/permits held by TM Rural Water District, and Todd M. and Merlyn Hofer (Water Right No. 4752-3). Historic water use from the Basal-Outwash aquifer is shown in Figure 10.

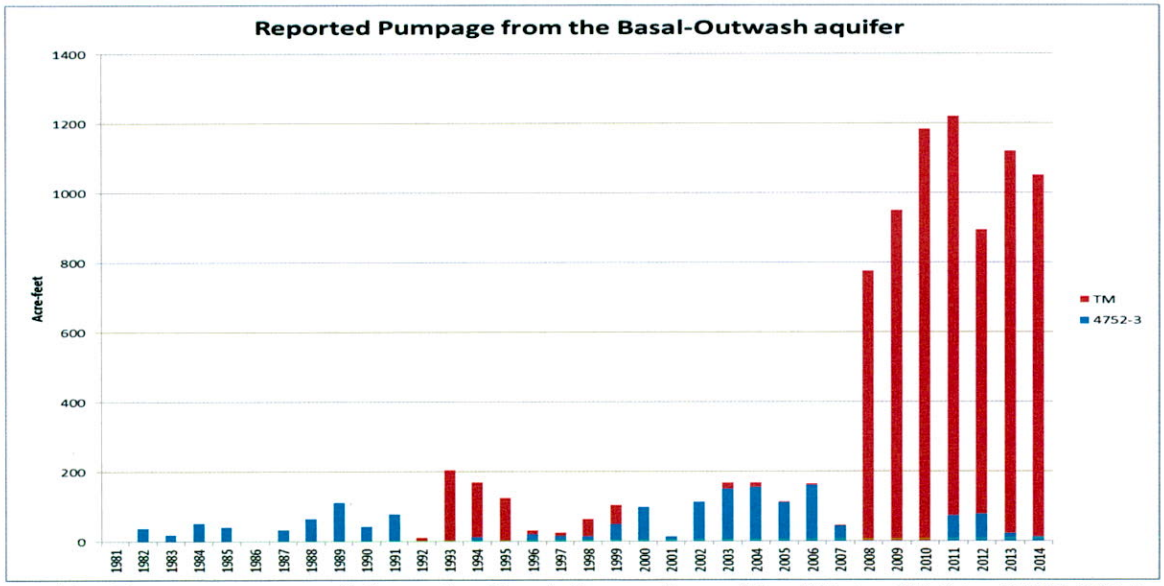


Figure 10. Pumpage reported from the Basal-Outwash aquifer (Water Rights, 1982-2014; and Water Rights, 1992-2015)

Well withdrawals from the Basal-outwash aquifer have increased from a 1981-2007 average annual withdrawal of 78 acre-feet/year to a 2008-2014 average annual withdrawal of 1,028 acre-feet/year (Water Rights, 1982-2014; and Water Rights, 1992-2015). The water level decline that occurred between October 2007 and October 2008 in the observation wells completed into the Basal-outwash aquifer is shown in Table 2.

Table 2. October 2007 through October 2008 decline of water level as measured in DENR-Water Rights' observation wells completed into the Basal-outwash aquifer.

Observation Well	Change in Water Level between October 2007 and October 2008 (feet)
TU-82A	-16.7
TU-90A	-12.1
TU-83A	-12.1
MC-83JR	-8.6
MC-83G	-8.7

The water level changes measured in these observation wells appear to coincide with pumping and the resulting drawdown from TM Rural Water District's two production wells.

The data used to generate Figure 8 was separated into three sections: pre-January 2007; January 2007 through January 2012; and post-January 2012. Overlays of area hydrographs for these time periods are shown in Figures 11-13.

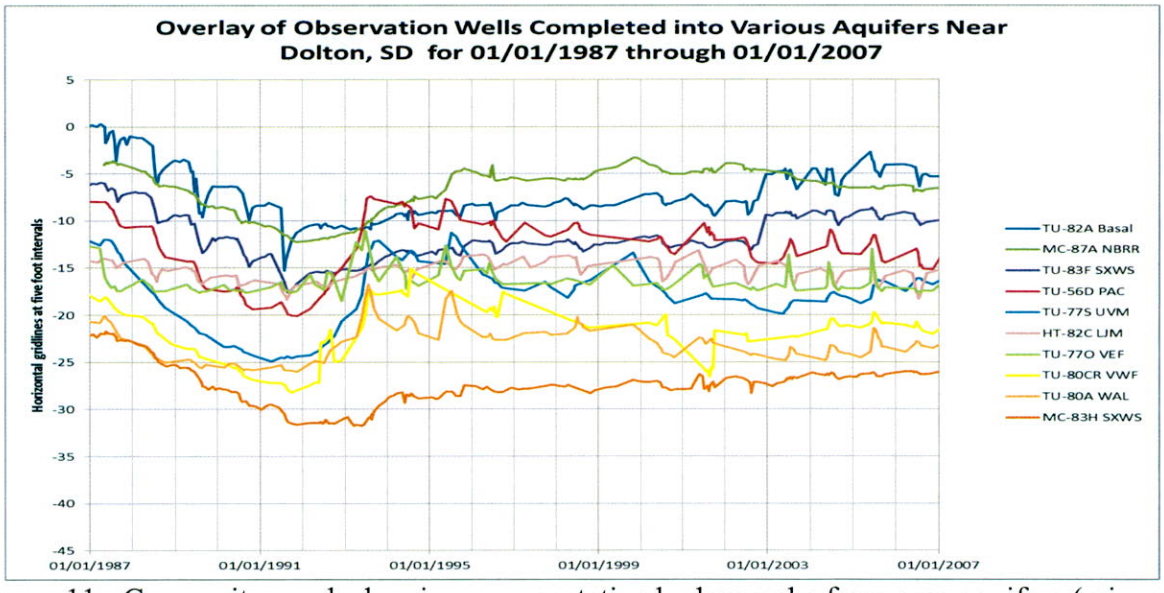


Figure 11. Composite graph showing representative hydrographs from area aquifers (minus the Dolton and an isolated portion of the Niobrara aquifer) from January 1, 1987 through January 1, 2007 with mean sea level elevation eliminated to allow comparisons of water level fluctuations (Water Rights, 2015a).

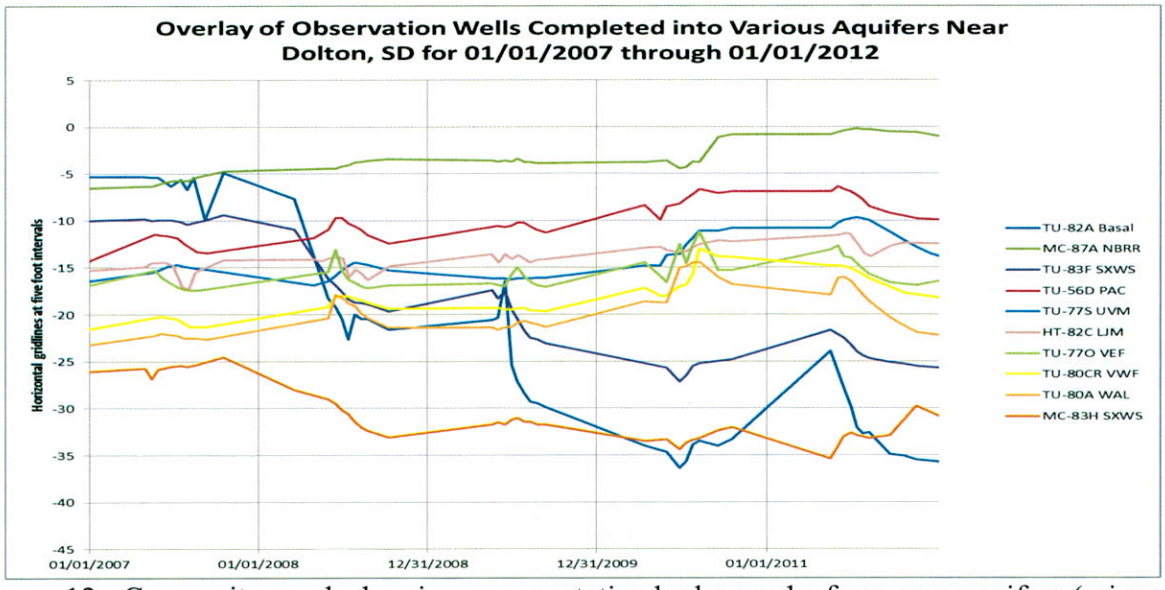


Figure 12. Composite graph showing representative hydrographs from area aquifers (minus the Dolton and an isolated portion of the Niobrara aquifer) from January1, 2007 through January 1, 2012 with mean sea level elevation eliminated to allow comparisons of water level fluctuations (Water Rights, 2015a).

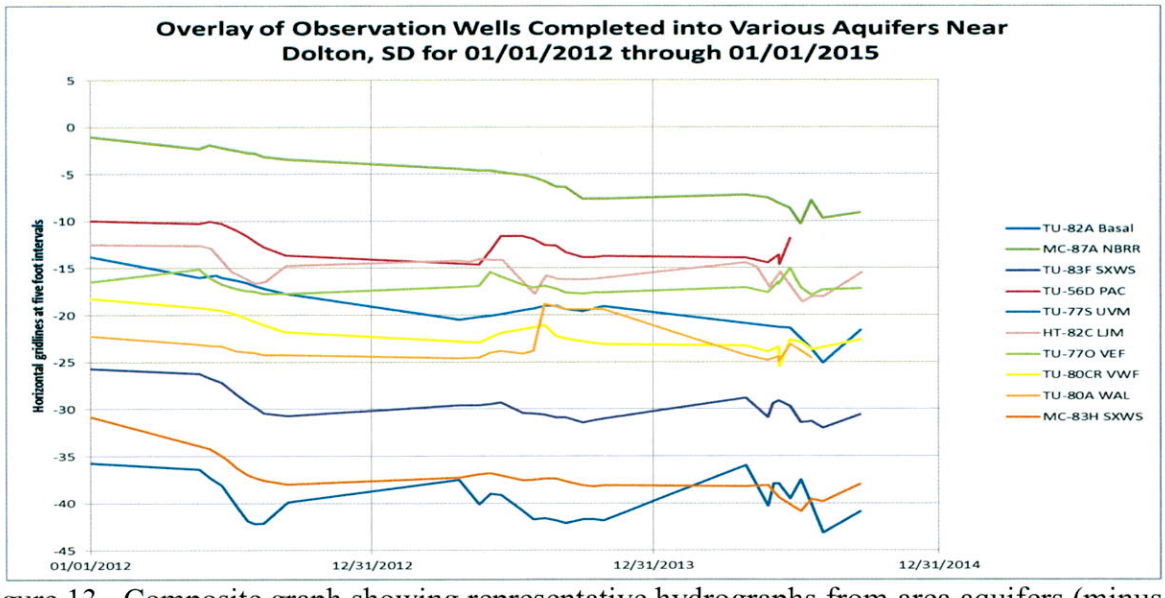


Figure 13. Composite graph showing representative hydrographs from area aquifers (minus the Dolton and an isolated portion of the Niobrara aquifer) from January 1, 2012 through January 1, 2015 with mean sea level elevation eliminated to allow comparisons of water level fluctuations (Water Rights, 2015a).

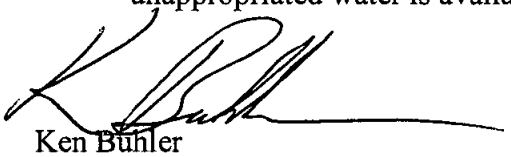
The hydrographs shown in Figure 11 show similar responses and climatic conditions appear to dominate the water level fluctuations of all of the aquifers from 1987-2007. The hydrographs in Figure 12, show the water levels of the Basal-outwash and Sioux Quartzite Wash aquifers

generally declined through 2008 and 2009 while the hydrographs for the other aquifers generally showed ascending water levels (presumably climatically dominated). Since 2012, the water level fluctuations of Basal-outwash and Sioux Quartzite Wash aquifers have appeared similar to the other aquifers in the area (presumably climatically controlled) (see Figure 13).

Continued pumping will usually expand the cone of depression in the aquifer until recharge areas are intercepted, causing the rate of water-level decline to be significantly reduced or stopped. It appears that additional recharge to the Basal-outwash aquifer has been induced from the Sioux Quartzite Wash aquifer and a new steady state has developed. However, the period of record is limited (2012-2014), and it may be premature at this point to state that recharge and withdrawals have equilibrated. There is not enough information available at this time to determine whether unappropriated water is available from the Sioux Quartzite Wash aquifer in this area.

CONCLUSIONS:

1. Water Permit Application No. 8068-3 proposes to appropriate water at a maximum diversion rate of 0.11 cfs from two wells to be completed into the Sioux Quartzite Wash aquifer.
2. Water levels in observation wells completed into the Sioux Quartzite Wash aquifer have declined significantly since 2007.
3. The Basal-outwash and the Sioux Quartzite Wash aquifers appear to be responding to similar hydrologic conditions that are not affecting other aquifers in the area, and/or a hydrologic connection exists between the aquifers.
4. The water level changes measured in these observation wells appear to coincide with pumping and the resulting drawdown from TM Rural Water District's two production wells.
5. Continued pumping will usually expand the cone of depression in the aquifer until recharge areas are intercepted, causing the rate of water-level decline to be significantly reduced or stopped.
6. It appears that additional recharge to the Basal-outwash aquifer has been induced from the Sioux Quartzite Wash aquifer and a new steady state may have developed.
7. A sufficiently long period of record is not available to determine if water levels have equilibrated in the Sioux Quartzite Wash aquifer in this area.
8. There is not enough information available at this time to determine whether unappropriated water is available from the Sioux Quartzite Wash aquifer in this area.



Ken Buhler
SD DENR-Water Rights Program

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Water Rights. 2015c. Water Well Completion Reports, SD DENR-Water Rights Program, Joe Foss Bldg., Pierre, SD.